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Puzzling thermonuclear bursts from the transient low-mass X-ray binary IGR J17473-2721

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Nuclear burning regimes

Theoretical thresholds:

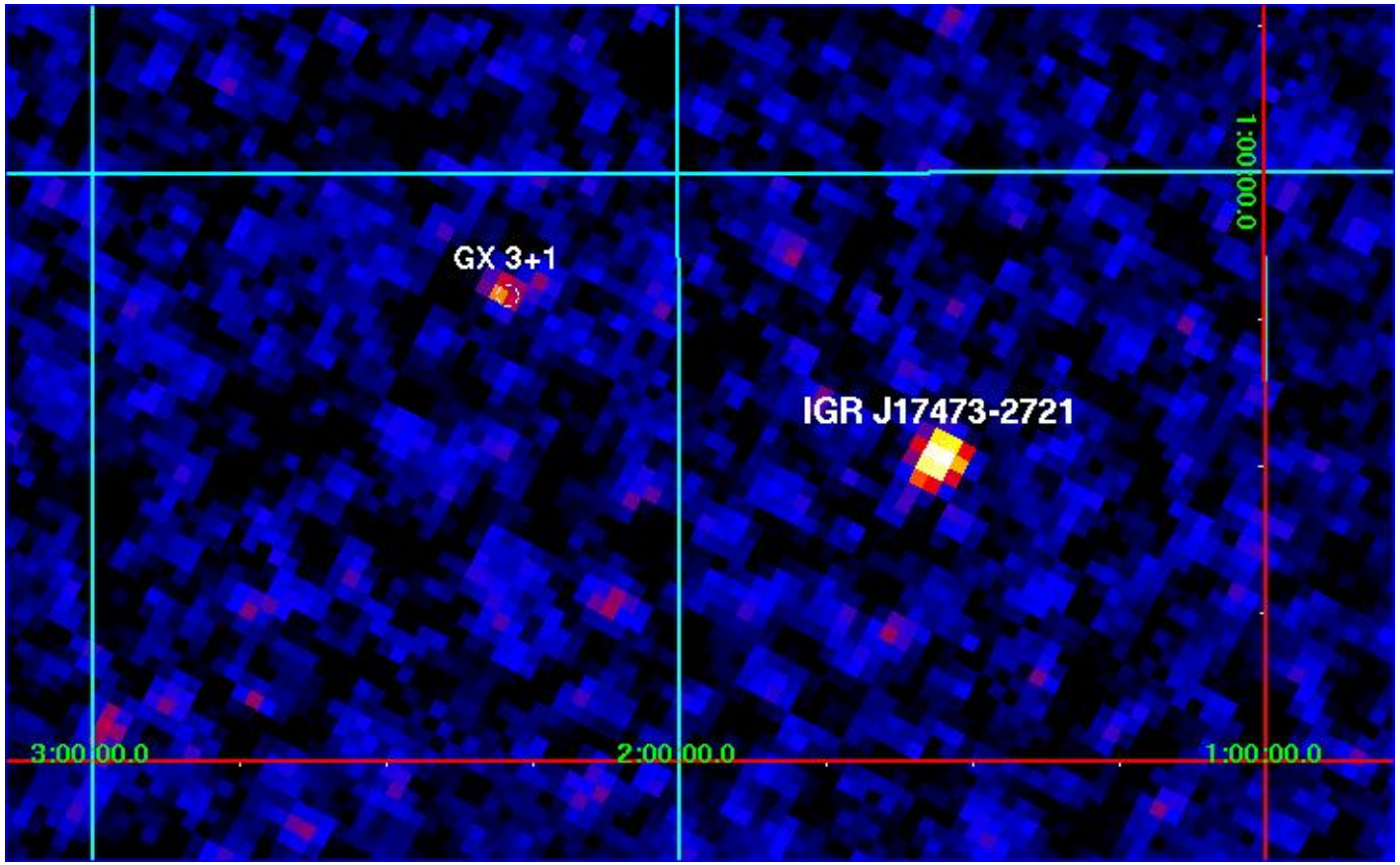
- $\dot{m} < 900\ \mathrm{g/cm^2/s}$: Mixed H/He burning triggered by thermally unstable H ignition.
  Long burst duration (> 100s - 1000s) due to rp- process. $\alpha \approx 150$.
- $900 < \dot{m} < 2000\ \mathrm{g/cm^2/s}$: H stable burning (hot CNO cycle) to He
  $\Rightarrow$ Pure He flash (3-α). Frequent PRE. $\alpha \approx 200$.
- $2000\ \mathrm{g/cm^2/s} < \dot{m} < \dot{m}_{Edd}$: Mixed H/He burning triggered by thermally unstable He ignition.
  Burst duration > 10s due to rp- process. $\alpha \sim 20\text{-}100$.
- $\dot{m} \geq \dot{m}_{Edd}$: No bursts (e.g. pulsars). $\dot{m}_{Edd} = 10^5\ \mathrm{g/cm^2/s}$

H unstability

He unstability

- Thick He burning (e.g. pure He accretion in UCXB) $\Rightarrow$ Long He bursts ($\sim 10^{41}$ ergs).
- Deep Carbon burning in superbursts (duration ~hours, released energy $\sim 10^{42}$ ergs).

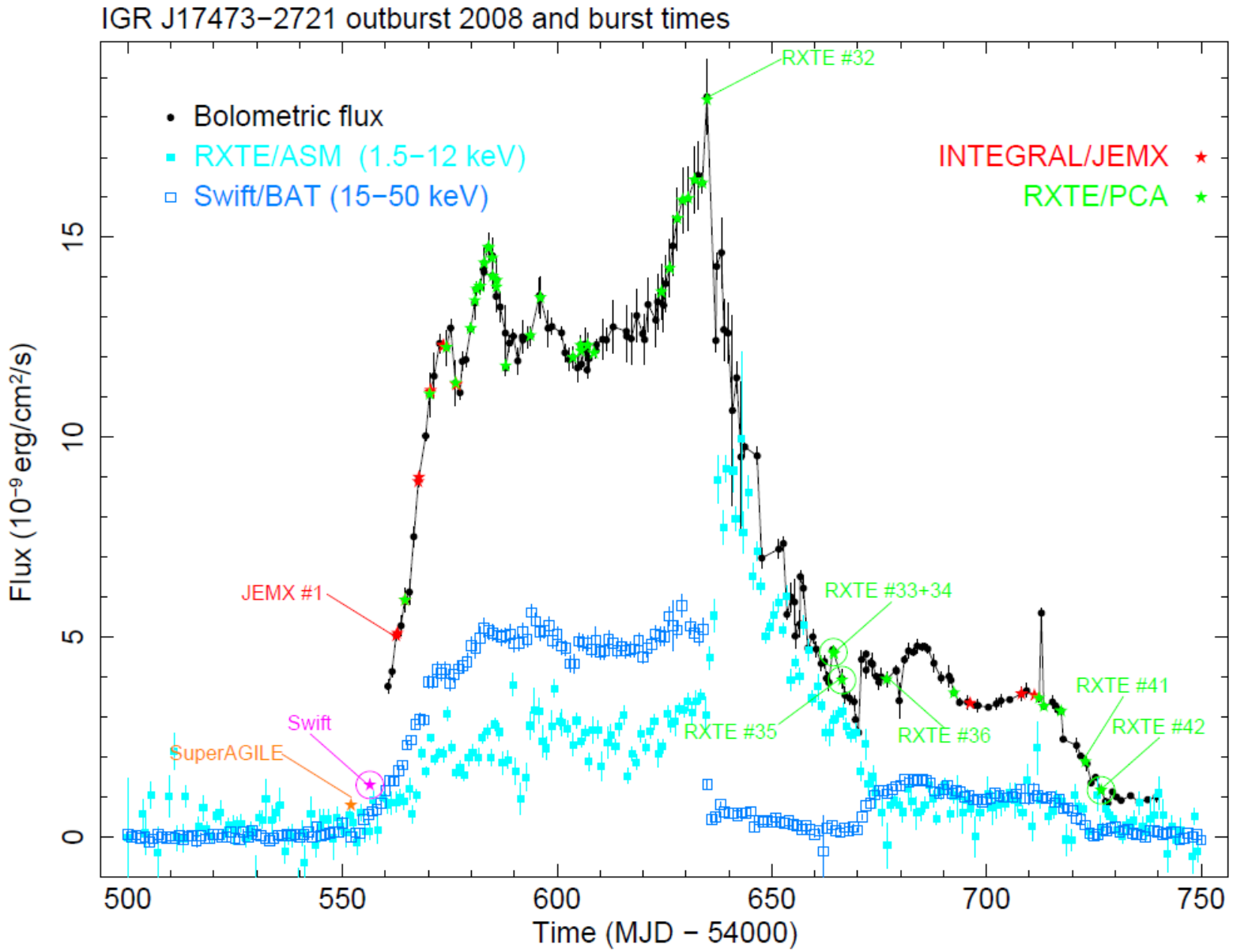
IGR J17473-2721 aka XTE J1747-274



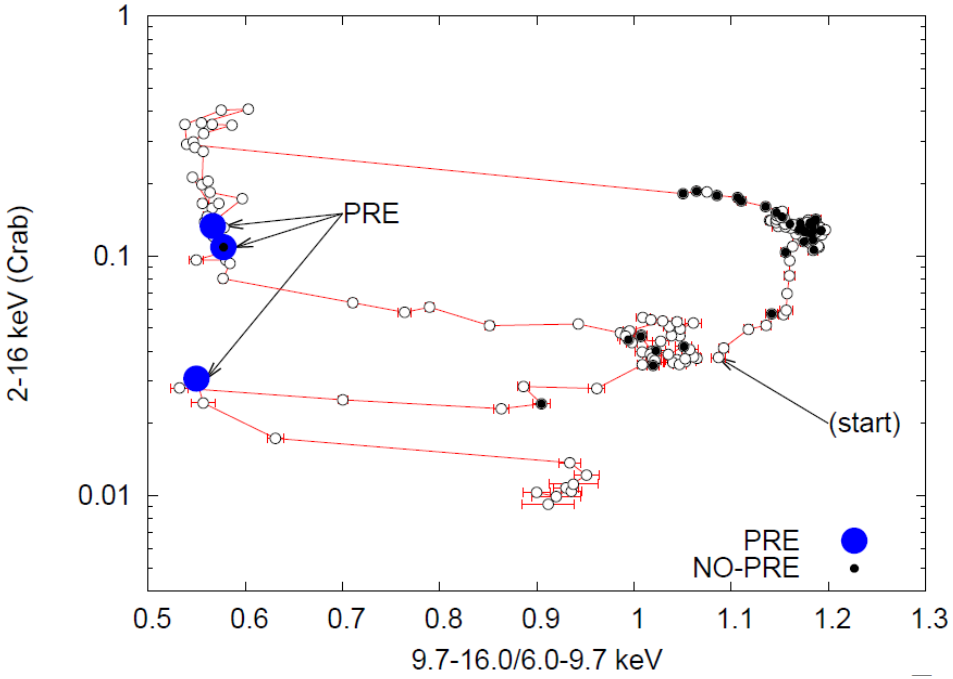
JEM-X
5-10 keV
6/4/2008

- Located in the Galactic Bulge, 0.8º from GX 3+1
- Transient X-ray source, discovered in 2005 (Grebenev et al., ATel 467)
  NIR counterpart (ATels 521, 634) - 2 (unpublished) X-ray bursts in RXTE
- 2nd outburst March – September 2008 (ATels 1445, 1459, 1460, 1461, 1468, 1651)
  INTEGRAL + RXTE + Swift coverage (57 X-ray bursts)

Outburst with sudden spectral transition



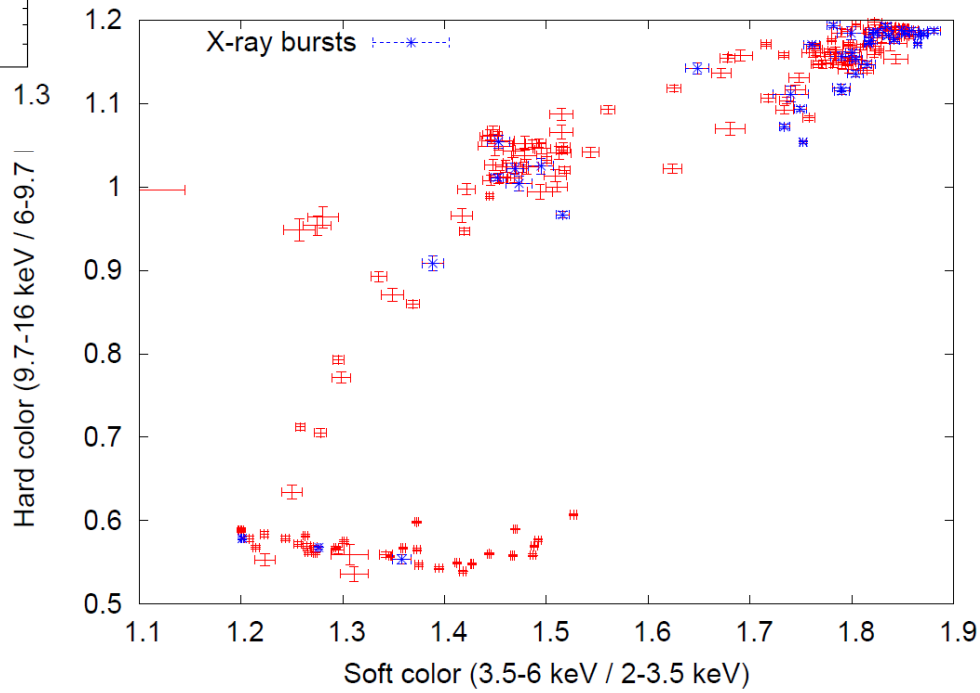
Diagrams of the 2008-outburst



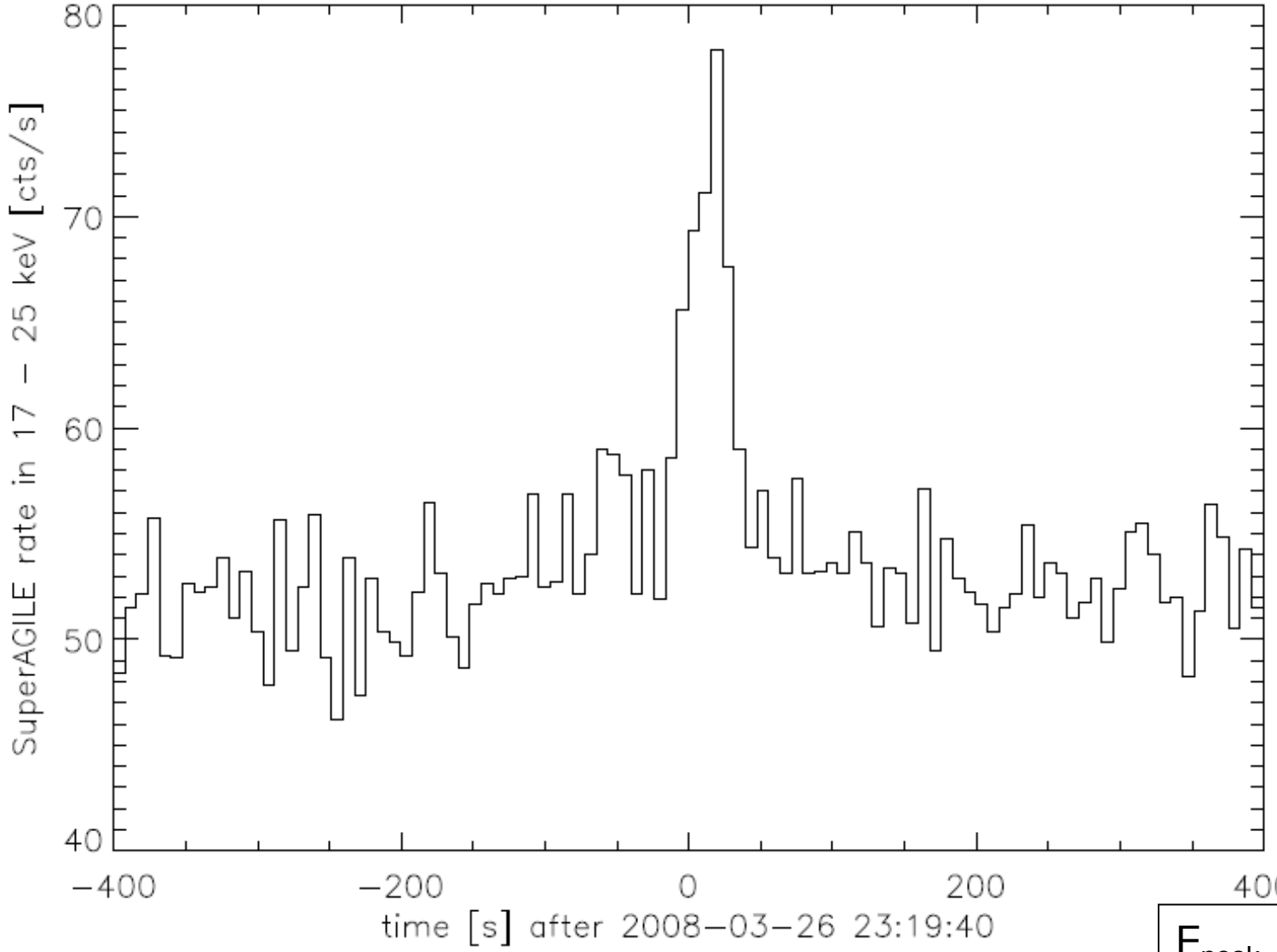
HID

From RXTE/PCA measurements

CCD



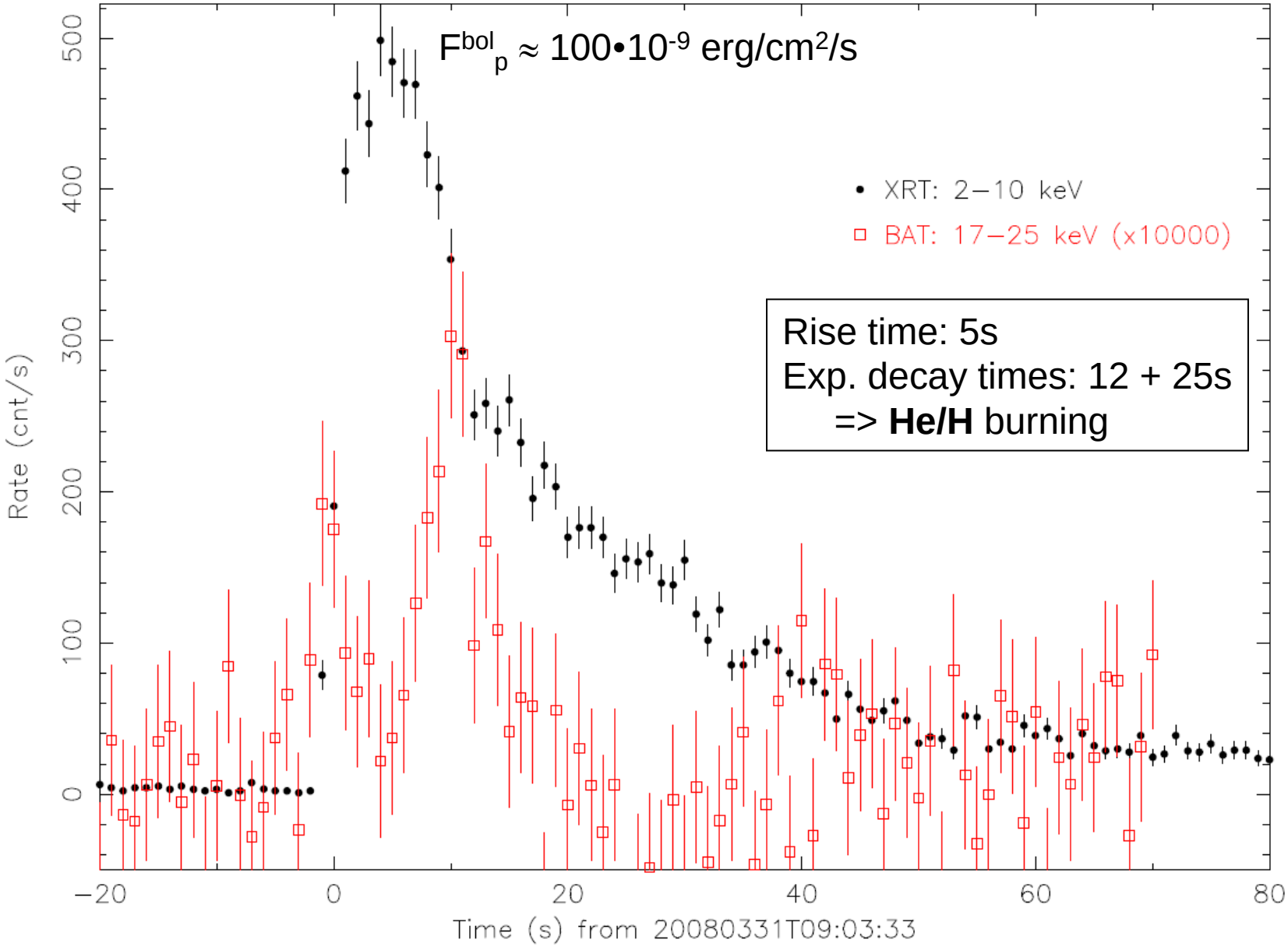
Burst as precursor of outburst?



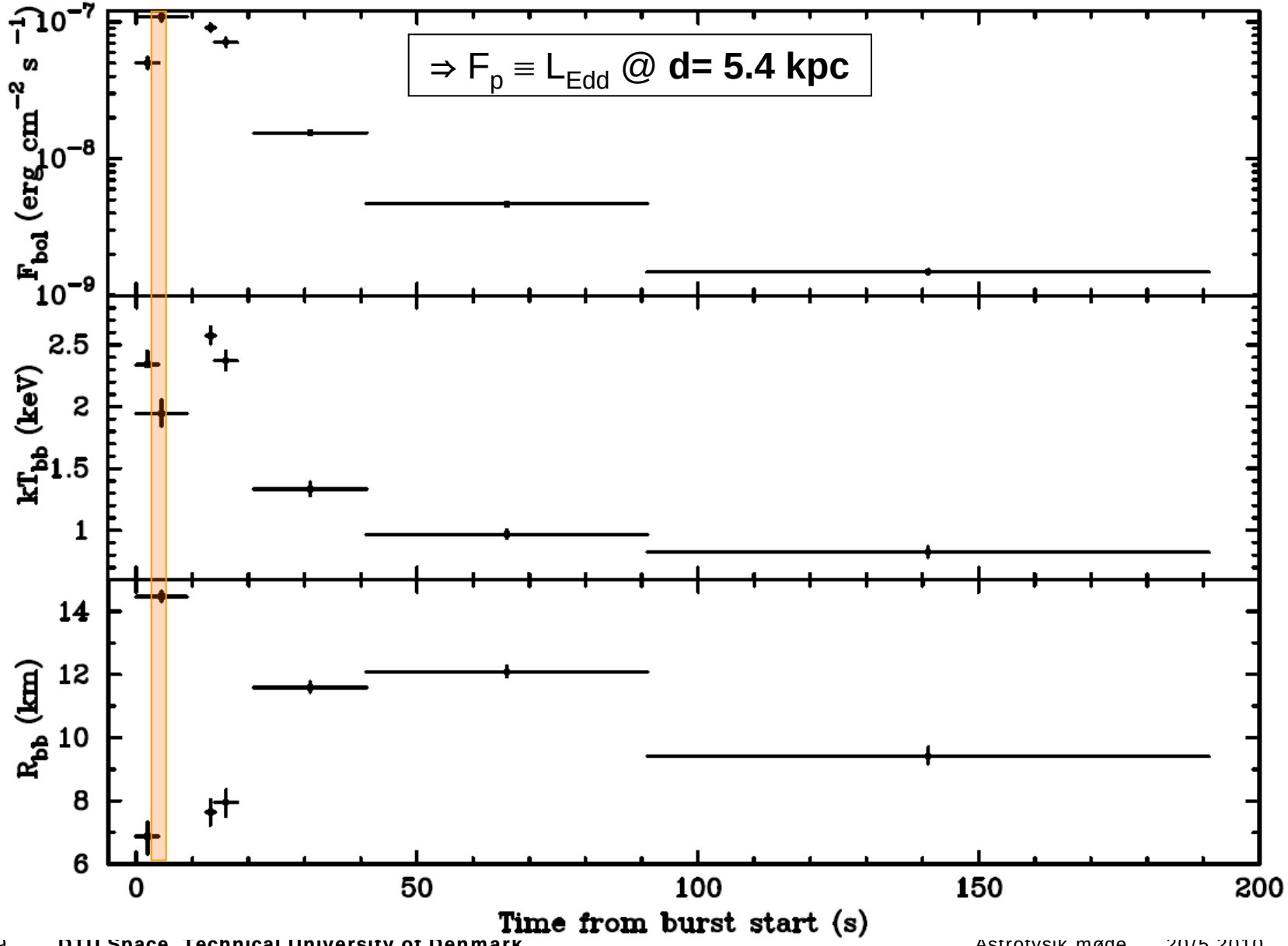
F_{pers} ~10^{-10} erg/cm^2/s

F_{peak} ≈0.5 Crab
Duration ≈44s

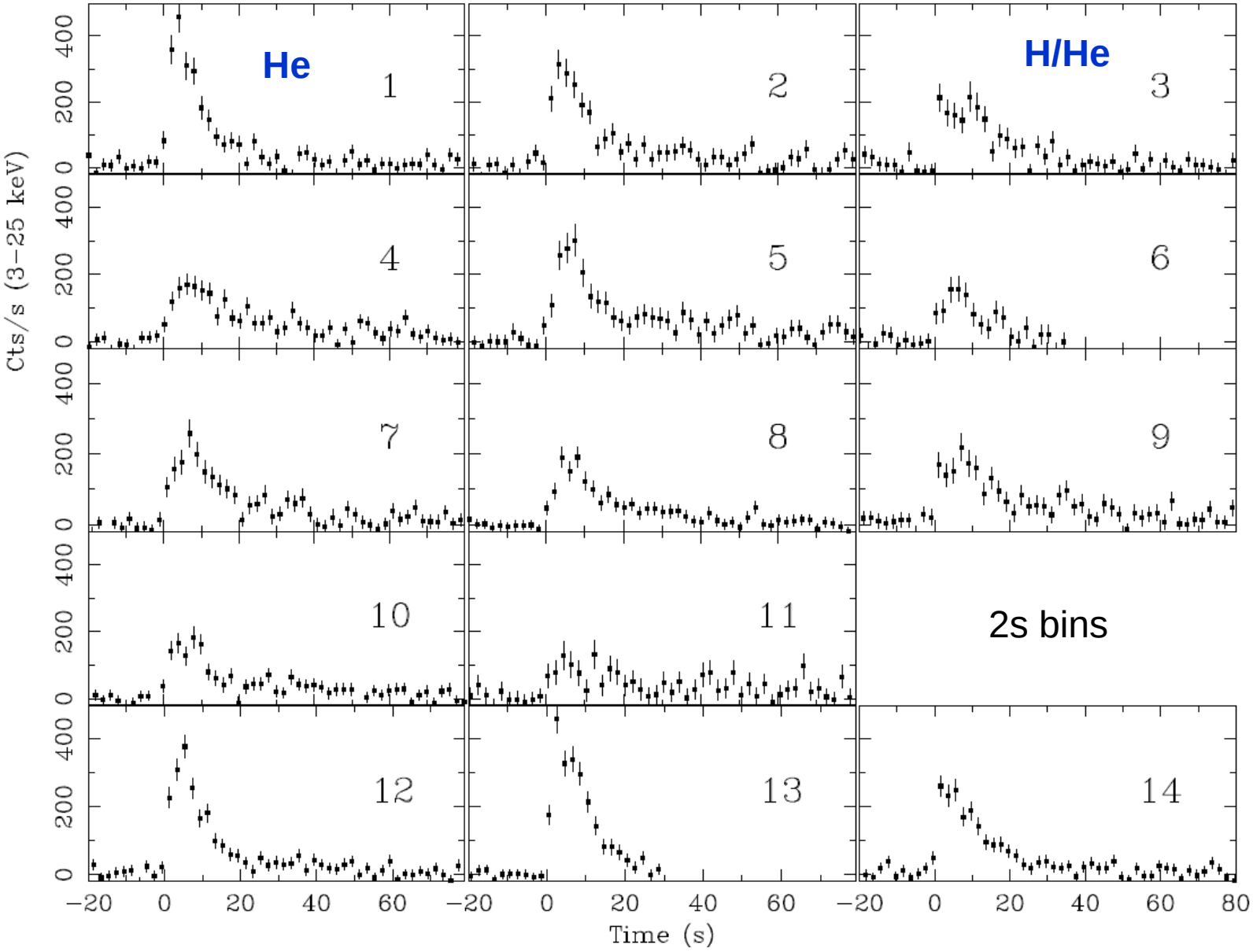
The burst observed by *Swift*



Time-resolved spectral analysis of the *Swift* burst



JEM-X bursts



Rise: 3-9s
τ: 10-30s

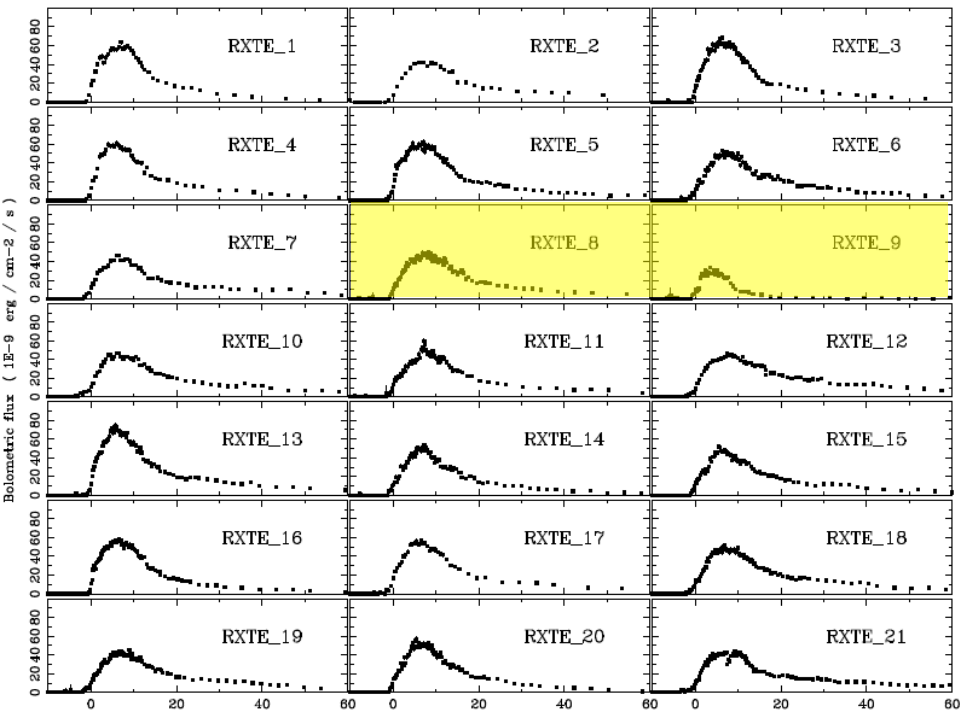
H

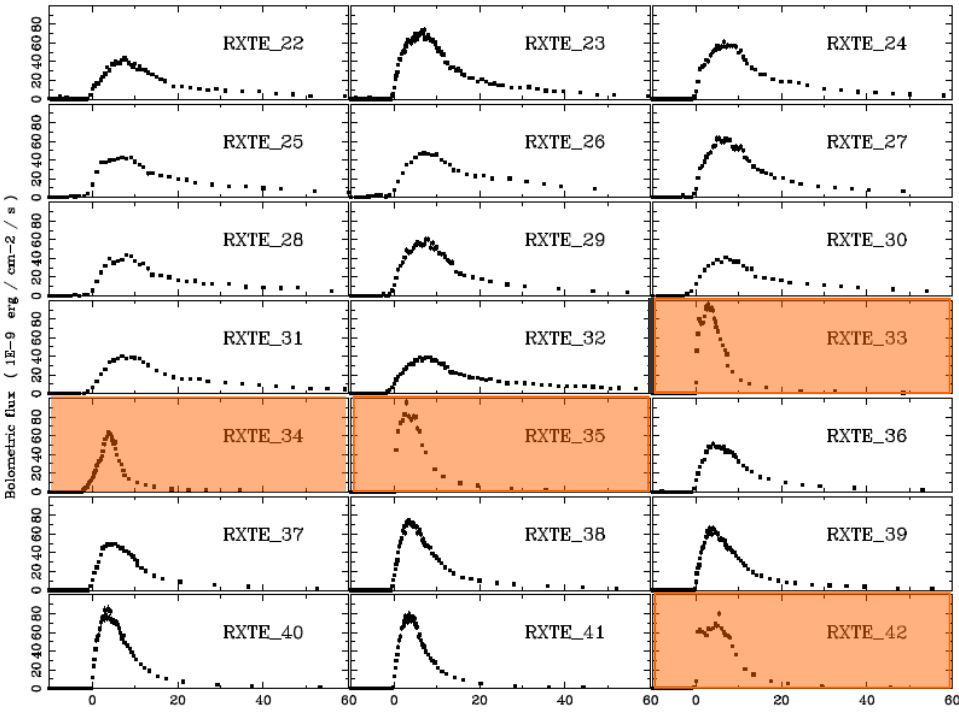
Rise: 1-5s
τ: 7-14s

He/H

42 *RXTE*/PCA bursts

He/H (stable H)





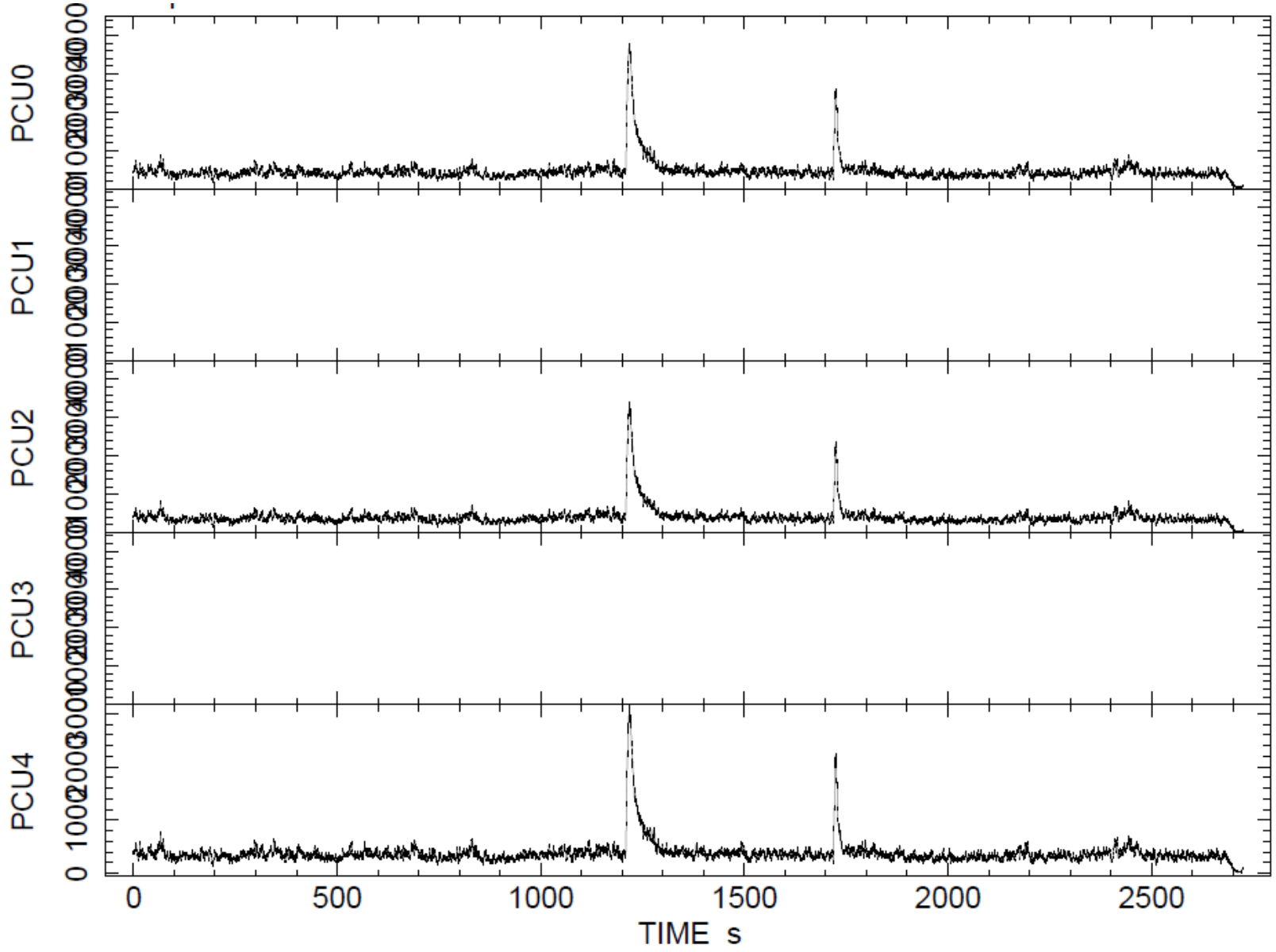
H/He

Rise: 6-9s
τ: 10-18s

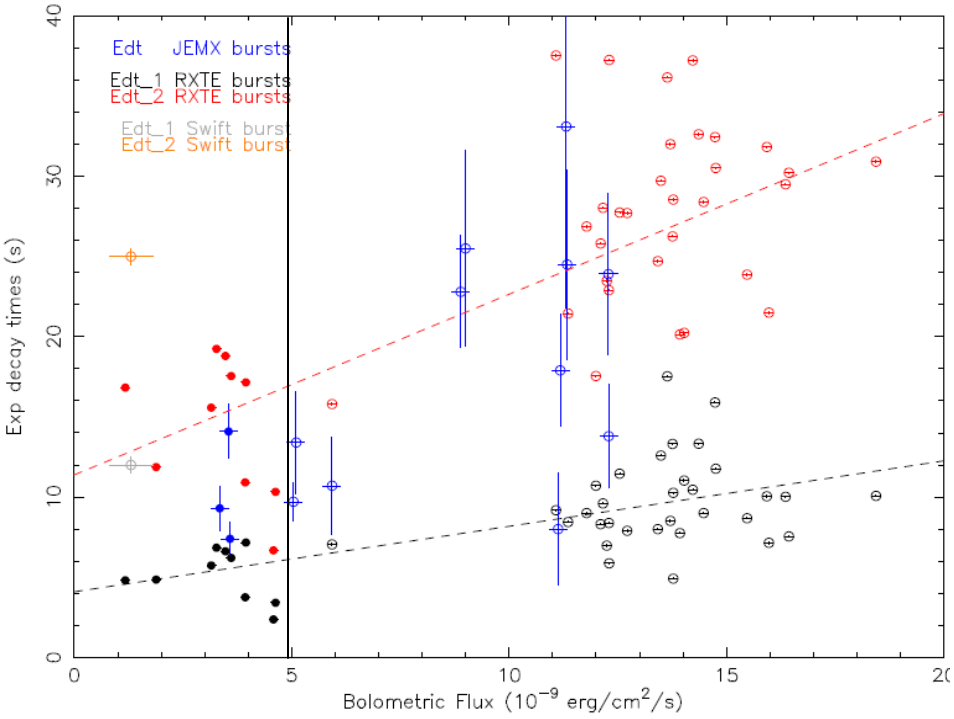
(stable He) **He**

Rise: 2-5s
τ: 8-16s

A double burst observed by *RXTE*/PCA

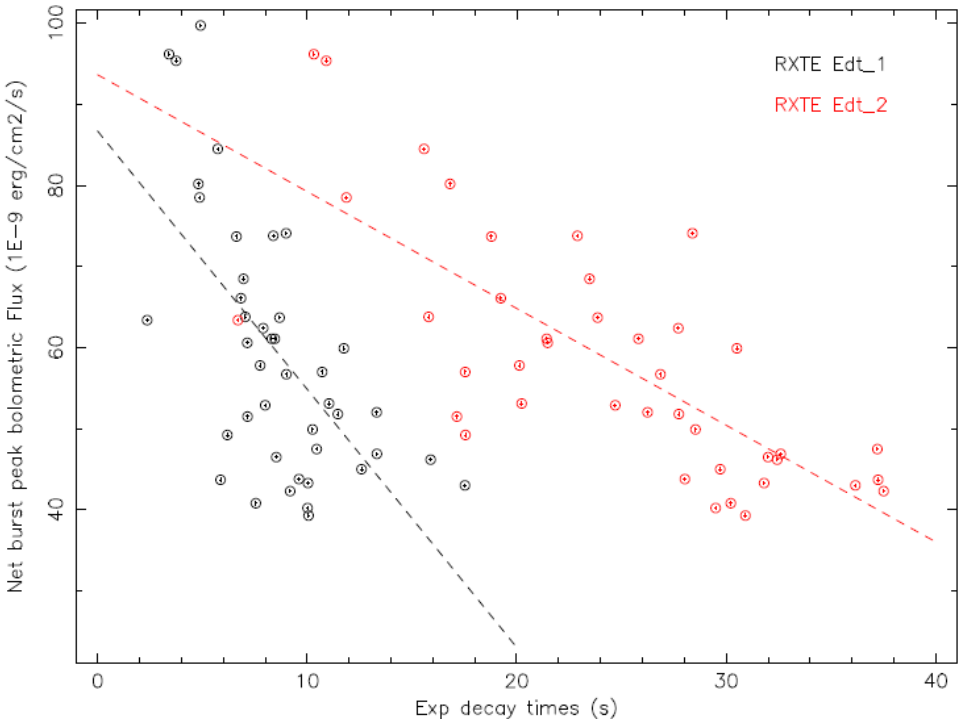


Burst properties

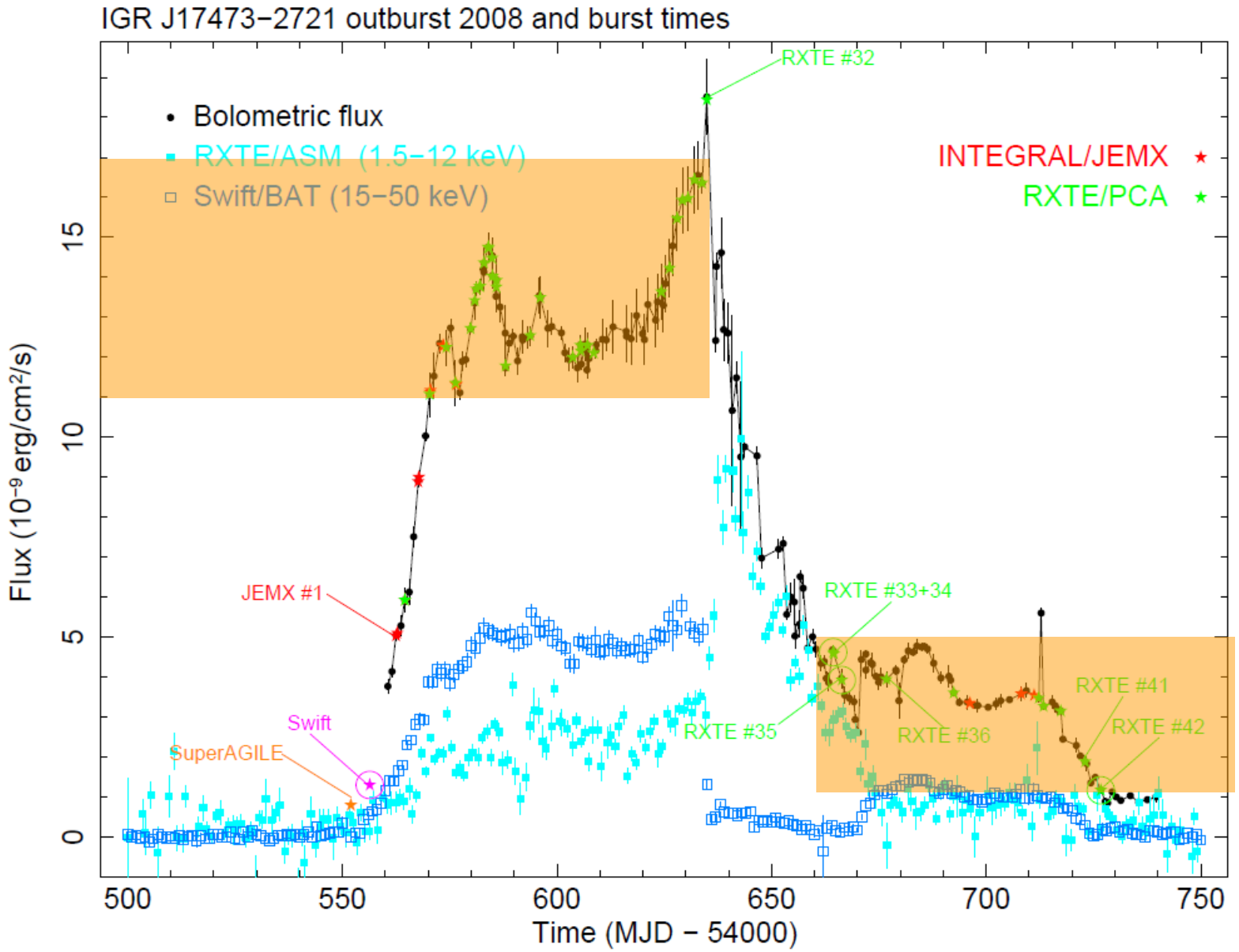


Burst decays vs. emission intensity

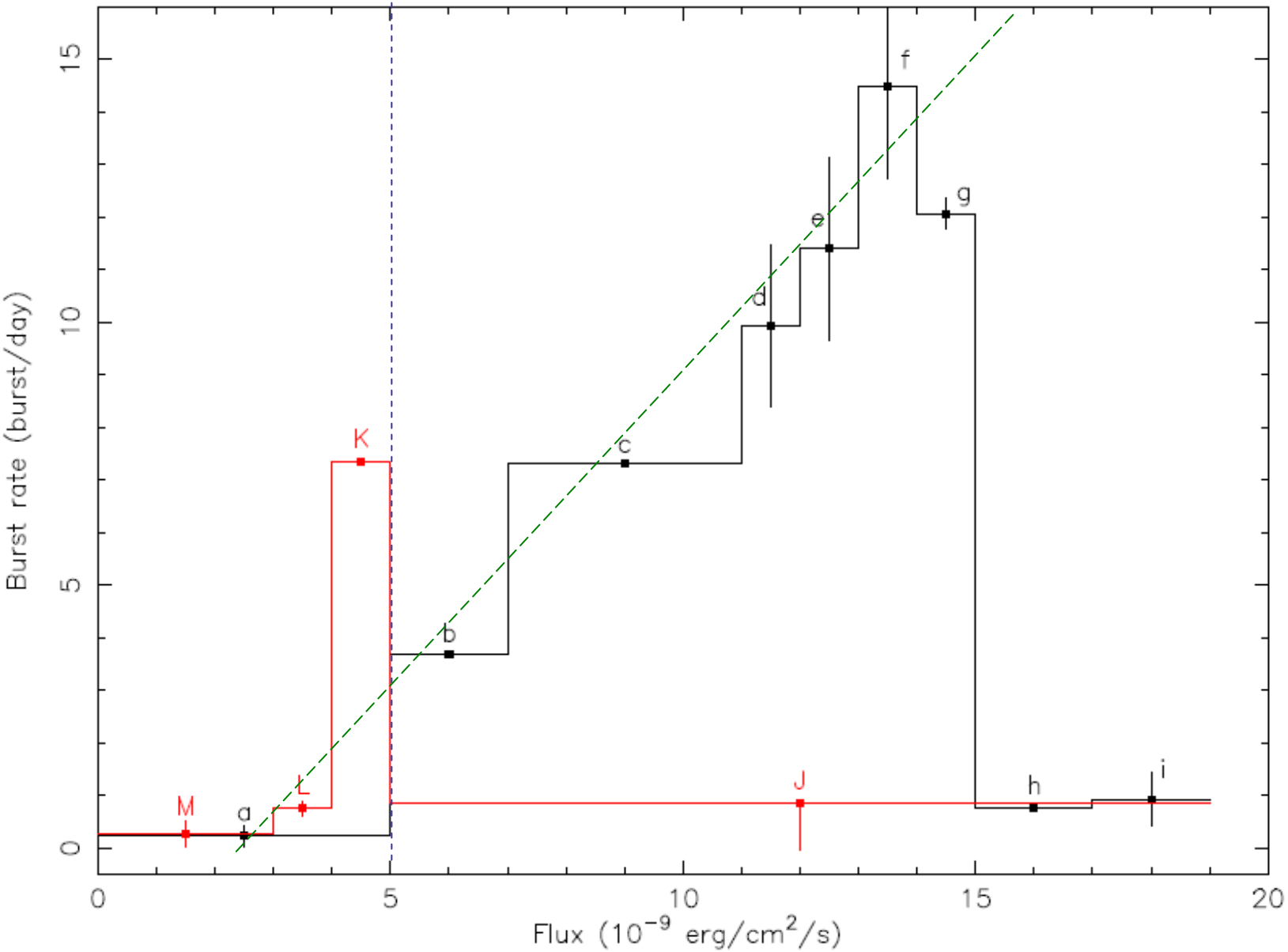
Burst intensity vs. decays



Outburst with sudden spectral transition



Burst rate vs. accretion rate



SUMMARY

- Identification of IGR J17473-2721 as a transient NS –LMXB source
- Dramatic spectral transition simultaneous with burst intermission at outburst peak.
- Distance ≈5.5 kpc derived from Eddington-limited PRE bursts
- 57 X-ray bursts ⇒ 7 different regimes identified:
    1. Hard He bursts at outburst onset (very low accretion rate)
    2. He-trig. H/He bursts in hard state (short recurrence times)
    3. He/H bursts with H & He stable burning at high accretion rate
    4. No burst activity at soft-high state (due to a **SUPERBURST**?)
    5. Pure He bursts (with PRE) at soft-low state
    6. Mixed He/H burning at hard-low state
    7. Last He burst at low accretion rate in soft state
- Rising bursting rate < 15% Eddington accretion rate and **hysteresis**